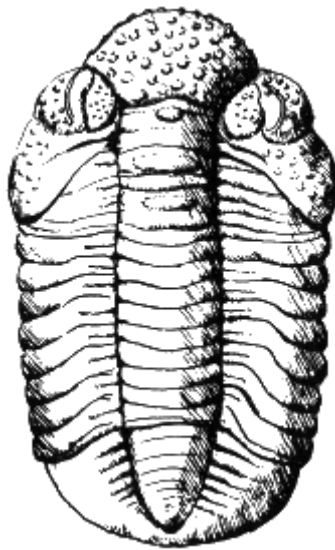


Indiana State Museum

Educational Opportunities for Your Students

Fossils



Lesson Plan
Text, Activities and Resources
Grades 4-6

Fossils

Grades 4-6

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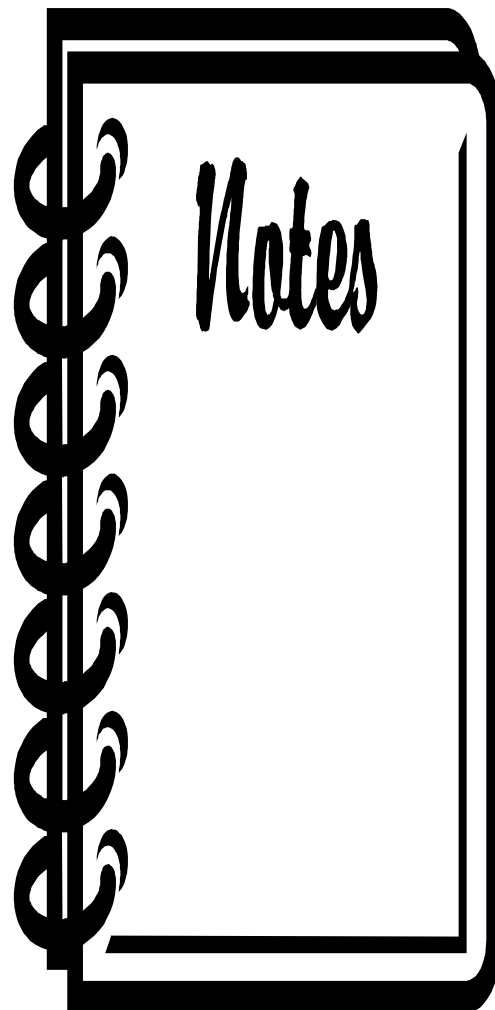
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INTRODUCTION

The study of fossils is a key element in understanding our past. Fossils can give us clues about how humans and different animals lived and evolved. This lesson plan incorporates oral and written language, reading, vocabulary development, science, social studies, and critical thinking. The lessons contained in this packet are intended for grades 4-6. The activities are designed to be innovative and to meet Indiana Academic Standards. The Background Text for Educators also can be used as text for students. The text and worksheets are reproducible.

SETTING THE STAGE

To begin the lesson plan, you might want the environment of your entire classroom to reflect the ideas of science, geology and discovery. This can be achieved by incorporating this theme into bulletin boards, learning centers, art projects and whatever else you are doing in your classroom. When you set the tone of your classroom in this manner, learning becomes an all-encompassing experience for your students. We encourage you to use this lesson plan as a springboard to further knowledge about fossils and their importance in understanding history. This lesson plan is comprised of four general areas, *Geologic Time*, *Fossil Formation*, *Discovering Fossils*, and *Paleozoic Fossils*.



1. Geologic Time

Geologists are scientists who study the earth and its processes. Geologists can determine the age of the earth and major events that have occurred in its history. Geologists use a geologic time line when talking about the age of different rocks and fossils. Just as you and I have time units in our lives of years, months and days, time units for the age of the earth are split into different eras, periods and epochs. An **era** covers millions of years in the history of the earth. There are several **periods** in an era. Periods are sometimes split even further into **epochs**. Different eras, periods and epochs are characterized by major events in the history of the earth such as an ice ages, the evolution of new life forms, or mass extinctions.

The Precambrian starts with the beginning of earth (4.5 bya) and goes until the beginning of the Paleozoic era (544 mya). Precambrian rocks are the oldest on the earth, but are far below the surface in Indiana. Life on earth began about 3.8 billion years ago, during the Precambrian. The earth was soon dominated by microscopic plants and animals.

During the **Paleozoic** era (544 mya - 248 mya), there was an explosion of animal life where many new kinds of living things appeared in the ocean, and life first emerged on land. Much of this life was preserved in the fossil record. The earliest exposed Indiana fossils come from rocks of the Ordovician period (505 mya - 440 mya). Paleozoic means “ancient life.” These ancient Indiana fossils can be up to 505 million years old! During the Paleozoic, Indiana looked much different than it does today. Indiana was warm like Florida, and was covered by a warm shallow sea filled with thousands of kinds of plants and animals. Toward the end of the Paleozoic, the coastal areas began to fill in, and the land became very swampy. Then, at the end of the Paleozoic, there was a great extinction where nearly every kind of Paleozoic animal was wiped out!

The **Mesozoic** era (248 mya - 65 mya) or “middle life” also has been called the “Age of Reptiles” and is split into three periods: the Triassic, the Jurassic and the Cretaceous. Most people recognize these periods as the time of dinosaurs and early mammals. Scientists are uncertain about what Indiana looked like during the Mesozoic and about which animals lived in Indiana during this time. Forces within the earth caused the Indiana region to be uplifted, and the evidence of life in Indiana during the Mesozoic eroded away. No dinosaur bones are found in Indiana! Sixty-five million years ago, at the end of the Mesozoic, there was another mass extinction, wiping out many species, including the dinosaurs.

The **Cenozoic** (“recent life”) is the most recent era, beginning 65 million years ago and is the era in which we live now. Just as the Mesozoic was known as the “Age of Reptiles,” the Cenozoic is known as the “Age of Mammals.” The extinction of the dinosaurs swept the earth clean of large animals. At last the mammals could come out of hiding. Within a few million years, mammals were the main large animals on earth. Birds first appeared during the Cenozoic as well. Remains of Cenozoic animals are scarce in Indiana (due to factors of erosion) until just this past epoch of the Cenozoic, the **Pleistocene**. The Pleistocene was characterized by the Ice Age and by many large mammals that are now extinct. It lasted from 1.8 million years ago to 8,000 years ago. The glaciers from the Ice Age were most likely at least partly responsible for the clearing away of Cenozoic animal remains.

2. Fossil Formation

What is a fossil?

Fossils are the traces or remains of plants or animals that lived long ago. In order to be considered a fossil, the remains must be at least 10,000 years old.

It is often just the hard part of the animal that is preserved as a fossil. For example, bones, teeth, and shells are often found as fossils. Hard parts of plants like wood or seeds are sometimes preserved as well.

A fossil also can be an insect trapped in **amber** or a mammoth frozen in the arctic. Traces of plants or animals such as footprints, leaf prints, eggs or burrows are fossils as well. Animal poop even can be fossilized if the conditions are just right! Fossilized animal poop is called a coprolite. Ancient sharks of the Paleozoic feasted on ocean fish and invertebrates which they sometimes later threw-up. The hard parts of the animals that the sharks ate, such as their bones or shells, were preserved as fossilized shark vomit (also known as a gastric residue mass). This jumbled mass of partially-digested animal remains can be found in some fossil-bearing rocks. Remember, *any* trace of an ancient plant or animal is considered to be a fossil. These fossils provide information about life thousands to millions of years ago.

How are fossils formed?

Not all ancient plants and animals became fossils. The conditions had to be just right. Plus, the process of changing from a living organism to a fossil takes thousands or even millions of years! As soon as animals and plants die, they begin to decompose or rot. The hard parts that are left (bones, teeth, wood, etc.) often will be scattered and broken up by animals, wind or flowing water. In order for something to become fossilized, it must be buried quickly, usually by mud or sand. These buried remains may be replaced with minerals from the surrounding soil which will gradually harden and form stone. Dinosaur bones and petrified wood are fossils of this type. The minerals present in the area where the plant or animal died will determine the color of the fossil. Fossils can be brown, tan, black or even a reddish color.

Imagine a leaf fluttering down and landing in mud. It is possible that this leaf will make an impression in the mud. The leaf will eventually rot away, but the impression may still be left in the mud. If this mud hardens and eventually becomes stone (a process which takes thousands of years), you will have a **mold** of that leaf. The mold left by a plant or animal which has decayed may fill with sediment. If this hardens, it will form a **cast**, an exact replica of that plant or animal in stone.

Fossils are found in **sedimentary rocks**. This is rock formed from sand, mud, clay or broken bits of shell that are often initially suspended in water. When these **sediments** settle to the bottom of the lake or sea, they build up in layers that solidify into rock. This process can take thousands of years to occur. **Limestone** is a type of sedimentary rock made from bits of shell, limy muds, or sea precipitates that have been compressed and cemented. Limestone is very common in Indiana and is often used as a building stone.

3. Discovering Fossils

The job of a paleontologist involves many different kinds of work. Paleontologists not only search for and collect fossils, but they also care for them, record information about them, and try to figure out what they tell us about past life and environments.

Collecting Fossils

A paleontologist does not look for fossils in a random fashion. Instead, he or she looks in specific places that are likely to have fossils. The oldest fossils in Indiana are found in sedimentary rocks. A good place to look for these fossils, therefore, is in an area where there is an **outcropping** of sedimentary rocks such as limestone, sandstone or shale. An outcropping occurs when part of a rock formation (from the underlying **bedrock**) is exposed due to erosion and shifting of the earth's crust. These outcroppings commonly contain fossils of ancient sea animals. Southern Indiana is known for its fossil-bearing sedimentary rock outcroppings. Rivers also will carve their paths through bedrock exposing fossil-bearing rock. Limestone, a sedimentary rock often used as a building stone, frequently contains very small fossils of ancient sea creatures. A close look at a limestone building can reveal such fossils.

Fossils are sometimes found in **glacial till**. Glacial till is rock and sediment left by a glacier. The rocks and fossils found in the till are usually not native to Indiana but instead were brought down from the north (Michigan and Canada) by glaciers during the Ice Age and deposited in Indiana when the glaciers retreated. The bedrock that could contain fossils is far below the surface in Northern and Central Indiana. The surface in these parts of the state is made up of glacial till.

More recent Indiana fossils come from the Pleistocene period, which is known for the occurrence of the Ice Age. These fossils are the remains of Ice Age animals, and can typically be found in caves, swamps, washed-out riverbeds and bogs. These fossils are much harder to locate and are often found by chance. Once a fossil site has been located, paleontologists are notified, and a dig is organized to recover any other animal remains.

Once an area that contains fossils has been identified, the next step is to collect the fossils. This may be difficult with Paleozoic fossils, since they can be trapped in the sedimentary rock. Paleontologists often will use a hammer and chisel to remove fossils from rock such as sandstone or limestone. Layers of shale can be picked apart by a pocketknife. Sometimes a dental pick is used to scrape away at the rock. A brush is then used to remove any dust or debris from the fossil. Many fossils are fragile, especially bone. These fossils could break or crumble if not treated with care. Paleontologists are extra careful with fossilized bone. To transport fragile bones of ancient animals, a paleontologist can wrap the bone in aluminum foil and then cover it with plaster for safe transport.

Most fossil skeletons do not come already assembled! In areas such as sinkholes, for example, there may be a giant pile of bones from several different types of animals. Paleontologists have the task of sorting out which bones belong to whom and then attempting to recreate what happened at the site.

Caring for Fossils

Once a fossil has been removed from the rock or surrounding soil, care is taken to preserve the fossil for study. If the fossil is a rare and valuable find, such as a complete skull of an extinct animal, the paleontologist will make a plaster **cast** of it. These casts preserve the details of the original and can be reproduced over and over for display or study. First, a rubber mold is made from the fossil. The mold is then filled with plaster to form a cast. This cast is an exact replica of the original. Many fossil skeletons on display at a museum are actually casts of the original, since the original may be too heavy to display, too fragile to display, or it may be incomplete.

Recording Information

Paleontologists record as much information about a fossil as they can. First, the paleontologist will record where the fossil came from. Layers of rock in the earth have different ages, and knowing from which layer of rock a certain fossil came from will help the paleontologist determine the age of the fossil. Location is important also when trying to reconstruct ancient environments. Fossils which are found nearby could give clues as to what other types of plants and animals were living at that time.

Fossils are labeled with a **genus** and **species** name. A genus is a group name given to plants and animals who are very similar and who are closely related. For example, lions, tigers, jaguars and leopards all belong to the same genus, *Panthera*. They are all big cats that share many characteristics. However, they are different from each other as well, and they belong to different species. A species is a more narrow classification, and is a name given to a group of plants or animals that are all of the same type. Members of a species are defined by their ability to breed with each other. A lion's scientific name is *Panthera leo*, while a tiger's is *Panthera tigris*. *Leo* and *tigris* are the species names. Jaguar skeletal remains (*Panthera onca*) have been found as fossils in Indiana. These Indiana jaguars, who lived here during parts of the Ice Age, belong to the same species of jaguar living in South America today!

4. Paleozoic Fossils

The Paleozoic

The Paleozoic Era lasted from approximately 544 million years ago to 248 million years ago. This is the oldest division of time from which Indiana has a fossil record. Since Indiana was much closer to the equator during this time, our state was much warmer. Indiana was covered by a shallow sea during most of the Paleozoic which is why the Paleozoic fossils we find in Indiana are almost all from creatures who lived in the sea.

Classification

A system was developed by scientists for sorting animals into groups based on the characteristics they shared. Just as we might divide land such as North America further and further into countries, states, counties, and townships, all living things are divided into Kingdoms, Phyla, Classes, Orders, Families, Genera, and Species. The groups of Paleozoic fossils listed below are the phyla and classes of common marine fossils found in Indiana. There may be several or just a few species of animals in each of these groups. Although many of the animals that lived in the Paleozoic are extinct, their relatives are living today. In the case of an animal like the trilobite, the relatives are very distant. In

the case of snails or clams, however, the living relatives are very similar to their ancestors 400 million years ago.

Paleozoic Fossils

Brachiopods are the most plentiful fossils from the Paleozoic. Brachiopods are sea animals having two unidentical shells (unlike clams which have two identical shells). The shells usually have ridges and sometimes have short knobs, suggesting spines in life. Brachiopods lived attached to the sea floor or attached to other seanimals. There are brachiopods living in oceans today, but with only 1% of the number of speices that lived in the Paleozoic.

Three types of Mollusk fossils are common in Indiana: Cephalopods, which include **nautiloids** and ammonites, Pelecypods or **clams**, and Gastropods or **snails**. Nautiloids are the ancestors of the modern nautilus, squid, and octopus. The shell could be cone-shaped or coiled and was chambered. At the large end was an open chamber where the animal lived. If it resembled its descendants, it had tentacles, eyes and a mouth with hard teeth. Pelecypods (clams) have two identical shells which can be smooth or ridged. There were salt water and fresh water clams during the Paleozoic. Gastropods are the snails. Ancient snails were found in the trees, in fresh water, and in the seas. Snails are characterized by having a single shell which is almost always coiled. Both clams and snails are living in sea water as well as fresh water today. Some modern snails also live on land.

Crinoids and blastoids are ancient echinoderms. Modern echinoderms include sea animals such as sand dollars, star fish and sea urchins. Blastoids are extinct, but crinoids are still living in seas today.

The crinoid is one of Indiana=s most prized fossils. Fossil beds near Crawfordsville, Indiana produce some of the world=s finest and best preserved specimens. A crinoid may look like a flower, but it is really an animal anchored to the sea floor by a **segmented** stem and root structure. Most often, it is this segmented stem that becomes fossilized. Sections of fossil crinoid stems are sometimes called AIndian beads@ since they look like beads and even can be strung together to make a necklace! The crinoid body at the top of the stem had flexible tentacles or arms which collected nutrients from the ocean water and directed them to the animal=s mouth.

Anthropods are animals which include insects, spiders, horseshoe crabs, centipedes, millipedes, pill bugs, lobsters, crayfish, and the extinct **trilobite**. Trilobites had segmented bodies, a hard jointed shell like a beetle=s that was shed several times during its life and compound eyes like a fly. It is thought to have eaten the nutrients in mud, just as earthworms do today. When trilobites felt threatened or scared, they curled up like a pill bug. Horseshoe crabs are the closest living relative of a trilobite. Trilobites ranged from an inch or two long to nearly two feet! They were very successful, existing for nearly 300 million years.

Coelenterates include jellyfish, sea anemones, and **corals** (anthozoans). All of these animals thrive in modern oceans just as they did in prehistoric seas. Corals are animals which can live either individually or in colonies. The living coral animal deposits a protective layer of limy material around itself. This is called the Askeleton.” It is the part of the coral that becomes fossilized. The presence of fossil coral in Indiana proves that the seas which covered Indiana during the Paleozoic were at times

shallow and tropical. We know this because modern reef-forming corals grow most vigorously in warm, shallow water.

Prehistoric **bryozoans** built colonies which either were attached to the sea floor branching out like antlers, or were growing over the shells of other ocean animals. Their lifestyle was very similar to that of corals in that they produced a protective limy layer around themselves. Their feeding style, however, was more similar to the brachiopods. Although bryozoans are not as well recognized as corals, hundreds of types of bryozoans live in today's oceans.

During the later part of the Paleozoic, part of Indiana was exposed as dry land. Fossilized portions of tree bark, stems and roots appear in the fossil record. Fern fossils come from trees or plants with fern-like leaves. Fern fossils often are found in mold and cast form. Since these plant parts are soft and decompose rapidly, fern fossils will only form when buried quickly by sediment. When the sediment hardens and the fern rots away, a mold is left. Other sediment falling on top of this fern mold will create a cast. Sedimentary nodules can be broken open to reveal both the mold and the cast.

V O C A B U L A R Y

1. Geologic Time

Geologist - a scientist who studies the earth and its processes.

Paleontologist - a scientist who studies fossils and ancient life.

Era - a unit of geologic time made up of two or more periods. Eras span many millions of years.

Period - a unit of geologic time, often made up of several epochs. Periods can span millions of years.

Epoch - one of the shortest units of geologic time. Epochs span thousands of years.

Paleozoic (“Ancient Life”) - an era which lasted from 544 million years ago to 248 million years ago.

Mesozoic (“Middle Life”) - an era which lasted from 248 million years ago to 65 million years ago.

Cenozoic (“Recent Life”) - an era which lasted from 65 million years ago to the present time.

Pleistocene (“Ancient Recent”) - an epoch within the Quaternary period of the Cenozoic which is characterized by the Ice Age. The Pleistocene lasted from 1.8 million years ago to 8,000 years ago.

Time Abbreviations (Used in text)

ya = years ago

mya = million years ago

bya = billion years ago

2. Fossil Formation

Fossil - the trace or remains of an ancient plant or animal which is over 10,000 years old.

Mold - an impression of a plant or animal in rock formed when the living part of the plant or animal has rotted away.

Natural cast - a solid object that shows the shape of the fossil animal. Natural casts form when a mold is filled with sediments or minerals.

Amber - the sticky resin from a tree which has hardened to become stone.

Sedimentary rock - a type of rock made from sediments that have been compressed and/or hardened.

Sediments - small particles of materials such as mud, clay, sand, shells, or minerals.

Limestone - a sedimentary rock made from bits of shell, limy muds, or sea precipitates which have been compressed and cemented.

3. Discovering Fossils

Bedrock - a solid rock formation that is usually found below the surface of the earth, but will sometimes be exposed due to uplifting or erosion

Outcropping - a part of a solid rock formation that is exposed

Glacial till - rock and sediment deposited by a glacier

Plaster cast - an exact replica of a fossil made from plaster (casts are also occasionally made from other materials as well)

Genus - a biological grouping which includes plants or animals that have similar characteristics and that are closely related

Species - a biological grouping defined by the ability to interbreed

4. Paleozoic Fossils

Brachiopod - a marine animal having two unidentical shells.

Nautiloid (Cephalopod) - a marine animal with a head, tentacles, sharp teeth and a segmented shell.

Clam (Pelecypod) - a marine or freshwater animal having two identical shells.

Snail (Gastropod) - a marine, freshwater, or land animal having a single shell that is usually coiled.

Trilobite - an extinct animal from the Paleozoic that had an external skeleton, a segmented body, and jointed legs. Trilobites are extinct relatives of today's lobsters, insects, spiders, and centipedes.

Coral (Anthozoan) - a stationary marine animal that can live singly or in colonies.

Bryozoan - a marine animal with the lifestyle of a coral and the feeding mechanism of a brachiopod.

Crinoid - a marine animal with a segmented stalk and tentacles used to collect food.

Segmented - divided into sections.

DISCUSSION QUESTIONS

1. Geologic Time

How do paleontologists (scientists who study fossils and ancient life) know what Indiana looked like before humans were around?

Paleontologists can use fossils to determine what kinds of plants and animals lived in Indiana during a certain time period, and what the climate would have been like.

What evidence might paleontologists use to suggest that Indiana was covered by a warm shallow sea?

Since Paleozoic fossil remains are of ancient sea animals, we know that Indiana was once covered by a sea. We know that this sea was warm and shallow because the types of animals that lived there have relatives living today who inhabit tropical places. For example, modern corals typically inhabit warm shallow waters. The remains of ancient corals in Indiana would suggest that they lived in a similar environment. Since fern fossils are found in Indiana later in the Paleozoic, we know that Indiana did have some exposed land during this time, although it was most likely very damp and swampy, as the plants that grew there require moist environments.

How do we know which animals used to live in Indiana?

We know which animals used to live in Indiana because we find their fossils.

Do we know exactly what these animals looked like?

It is true that we know which animals used to live in Indiana because we find their fossils. However, we do not know exactly what these animals looked like, what color they were, or how they behaved, since we only find the remains.

What kinds of information can paleontologists learn from studying fossils?

Paleontologists gain clues as to the appearance and behavior of ancient animals by comparing them to modern relatives. For example, scientists can speculate on the feeding mechanism of the Paleozoic crinoids by studying modern crinoid species. By studying fossils, Paleontologists can learn about the variety and number of species that lived during a certain time period. They can determine the size of the animal. They can begin to reconstruct ancient environments. In some cases, fossil footprints can give an indication of how fast an animal could run. Fossil prints also can determine whether archaeopteryx had feathers, and whether an ancient human ancestor walked on two legs more than 3 million years ago. Fossil teeth give an indication of whether animals were meat-eaters or plant-eaters. Fossil remains of maiasaur nest sites with both infant and juvenile maiasaurs revealed that these dinosaurs protected and mothered their young for several years after the young dinosaurs were born.

2. Fossil Formation

Paleontologists rarely find complete skeletons of fossilized animals. Why might this be the case?

Many things can happen to a skeleton on its way to becoming a fossil. The bones may be gnawed at or taken away by hungry scavengers or they may be trampled by other animals. Weathering also will play a roll. Wind, rain, snow, and factors of erosion can cause bones to become scattered or broken apart. Unless the bones are buried quickly by sediments, they may not preserve at all.

Imagine you are touring a natural history museum and see fossilized dinosaur footprints on display. However, the footprints are not sunk down into the rock. Instead, they are sticking up! How can you explain this?

The rock on display is actually the *cast* of the footprints rather than the mold. It is true that if footprints fossilize, they will form an impression, or a mold in the rock. Imagine now that these footprints are covered by another layer of sediment which fills in the impressions. A fossil cast will form if this upper layer of sediment hardens. If the resulting rock is split open, there will be two halves - a fossil mold, and a fossil cast.

A chunk of petrified wood is much heavier than a chunk of wood from a tree today. Why?

Petrification is a process whereby water containing mineral matter replaces, particle by particle, the once-living tissues of plants and animals with the dissolved mineral matter. In essence, the wood is turned to stone. Stone is heavier than wood, and therefore, a chunk of petrified wood will be heavier than wood from a tree today.

Suppose you are out west and come across a cliff composed of layers of sedimentary rock. Would the oldest fossils from this cliff be from the top or the bottom? Why can we sometimes find fossils which are hundreds of millions of years old laying around on the surface of the ground?

The oldest fossils on this cliff would come from the bottom, since this was the layer which was laid down first. Erosion of the upper layers may cause the older layers underneath to be exposed, therefore exposing fossils which may be hundreds of millions of years old. Forces within the earth which cause the uplifting of certain areas can affect this process as well.

It is possible to come across a fossil that has not been fossilized! How is this so? Think carefully about the definition of a fossil and about some of the examples of fossils presented in the text.

To be *fossilized* means to be replaced by minerals. In order to be a *fossil*, however, something need only be the remains of a plant or animal which is at least 10,000 years old. Therefore, it does not need to be fossilized to be considered a fossil! Consider a mammoth bone for example. Mammoths were extinct by 10,000 years ago, so by definition, the remains of a mammoth are considered to be fossils. However, these remains have often not yet become fossilized. In fact, frozen mammoths have been found in the arctic that still have hair and flesh! In these cases, the mammoth and the mammoth bones are fossils, but these bones have not been fossilized.

3. Discovering Fossils

Imagine that you are visiting a natural history museum. A tour guide explains that 60% of the mastodont skeleton on display is real bone. Why might only 60% of the skeleton be on display? What is the other 40% of the skeleton made of?

Skeletons are often found incomplete due to forces such as weathering, disturbance by scavengers and being trampled. These affect the chances of a skeleton's complete fossilization. The other 40% of the skeleton is most likely made of plaster casts which are stained and painted to look like the originals. Sometimes these casts are made from bones of other mastodonts that have been discovered and would have been similar in size to the one on display. Fossil skeletons at museums can actually consist of several different animals of that species!

Why would a paleontologist be interested in the layer of rock in which a fossil is found?

The layer of rock, or **strata**, from which a fossil is found helps to determine its relative age. If a given layer of rock is known to be from the Devonian time period, then the fossils you find in this layer will all be 410-360 million years old.

Why would a paleontologist want to record all of the types of fossils found in a given layer of rock (strata)?

A paleontologist can get a sense of what the local environment was like and what communities of animals lived in this environment by recording all of the types of fossils found in a given strata.

Fossil bones are rarely found articulated or Aput-together@ as skeletons. Paleontologists have to build skeletons of these ancient animals based on the bones they find. Sometimes, even with missing bones, a complete skeleton can be created using real bones and creating the missing bones out of plaster. How then does a paleontologist know how to put together the skeleton of a brand-new species of animal?

The paleontologist doesn't know for sure how to put together the skeleton of a brand-new species of animal. However, he or she can make some good guesses about how to do this based on known animals that are thought to be related to the fossil animal in question.

In the past, scientists have come up with some crazy animal creations based on just a few bones. Today, however, with more extensive collections to study, missing bones can be created based on probable function or based on the same bones of related animals. For example, if a carnivorous dinosaur skull is found with a missing lower jaw, the paleontologist can make a good guess that the actual lower jaw of the dinosaur consisted of several bones (as all reptile lower jaws do) and pointed teeth (as all carnivorous reptiles have). Mistakes have been made however! For example, the dinosaur known as ABrontosaurus@ was based on a skeleton of a dinosaur without a skull. The skull of a different dinosaur was assumed to be the correct match and was put together with the discovered skeleton to create the dinosaur, ABrontosaurus.@ In reality, it was the skeleton of an Apatosaurus that was found and put together with the skull of Camarasaurus. Brontosaurus, therefore, should really be called Apatosaurus. Updated dinosaur books will have this correction.

Fossils of ancient sea creatures from the Paleozoic era are abundant in southern Indiana. They may be embedded in limestone on the side of a cliff or found at the bottom of a shallow creek. Why can a person find these fossils frequently in southern Indiana but rarely in northern Indiana?

Glaciers did not cover a portion of southern Indiana and therefore did not leave all of the sediment as they did in northern Indiana. Without the overlying sediment, the bedrock is exposed in southern Indiana, and this ancient rock contains fossils of sea creatures that lived in the Paleozoic era when these layers of sedimentary rock were formed. If one were to dig through the glacial sediment down to the bedrock in the northern regions, Paleozoic fossils could be found.

4. Paleozoic Fossils

Consider the life of a trilobite, living in the sea millions of years ago. It had a simple life of crawling along the sea floor in search of food while trying to avoid predators such as a hungry nautiloid. Trilobites were not very large, nor were they strong or powerful. Yet, trilobites existed on earth for 300 million years. This is more than twice as long as any of the dinosaurs and 3000 times longer than modern humans! What makes a group or species successful? Is it the range of climates and continents it can cover? Is it the size? Is it the number of species in that group or the number of individuals in that species? Is it how well that species can dominate other species? Or is it the amount of time that species can exist on earth relatively unchanged?

There is no sure answer for this question. Some may define success as the length of time a given species or taxonomic group has existed. Trilobites, sharks, dragonflies and ferns, by this definition, are very successful. Others may define success as the ability to adapt to many types of environments. Humans and beetles share this type of success. Humans alone have the capability of controlling and dominating other species for their own benefit, as well as possessing the power to wipe out hundreds and thousands of plant and animal species. Dinosaurs were the largest land animals that ever lived, and they ranged all across the world. Insects dominate the world in sheer number of species and individuals that exist. They are highly adaptable and have existed for millions of years.

Many of the Paleozoic marine animals mentioned have relatives who are living today. What can scientists learn about ancient animals by studying their modern relatives?

Since it is usually only the hard parts or skeletons of ancient animals that are preserved, the appearance of the soft bodies of the animal cannot be exactly determined. Likewise, behaviors of ancient animals, color and pattern cannot be determined by just looking at a fossil. Therefore, scientists turn to modern relatives to help answer such questions.

Why do scientists believe that the sea which covered Indiana during the Paleozoic must have been shallow at least some of the time?

Coral reefs, which today typically grow in warm, shallow water, were plentiful in Indiana during the Paleozoic. We know this because we find many coral fossils. Scientists believe that ancient corals were very similar to today's corals and probably needed the same environments in which to live.

Suppose that you are hiking with your family in an Indiana state park and come across some crinoid fossils. Is it okay to take these home with you?

Laws prohibit the collecting of fossils on state or federal property. If you look for fossils on private property, you must have permission from the owner to collect them. If your fossil find is rare, you may want to take it to a local university, natural history museum or to the Indiana State Museum to be identified.

CLASSROOM ACTIVITIES

Grades 4-6

Subject: Fossils

Duration: One – Five Classes

Activity 1

Objectives

- Students will be able to measure and relate to geologic time.

Indiana's Academic Standards

Social Studies: 4.1.13

Science: 4.1.5, 4.2.1, 4.2.4, 5.5.1, 6.7.2

Supplies:

One sheet of paper per group (sheets should be at least 6 meters long or 19.68 feet)

Metric rulers

Geologic time line (handout)

Colored pencils

Instructions:

Measure time by centimeters! You will need pieces of paper that are at least 6 meters long. Students should work in groups to complete this activity. Students will recreate a geologic time line of life on earth using one centimeter to represent one million years. For example, if the Mesozoic lasted 183 million years, then this space should be represented by 183 centimeters. Students should mark the beginning and end of the major geologic eras, periods, and epochs and include the respective dates. Students may also wish to color the chart and/or draw in pictures of representative animals.

Activity 2

Objectives

- Students will be able to comprehend geologic time.

Indiana's Academic Standards

Science: 4.2.1, 5.6.2, 6.7.2

Supplies:

Two 2-gallon containers

Birdseed (12 lbs.)

Instructions:

Fill a 2 gallon container with birdseed (approximately 12 lbs). This represents one million pieces of birdseed. Hand out one piece of birdseed to each student for each year old that they are. Explain that the students get one piece of birdseed every year on his/her birthday. This birdseed represents how old he/she is. Place this birdseed in an empty two gallon container. Ask the students how many years they would have to live to fill this container with birdseed. The answer- one million! Use this jar to talk about the age of the earth and of various fossils.

The earth itself is 4.6 billion years old. We would need 4,600 jars of seed to equal that amount. If we took those 4,600 jars and stacked them one on top of the other, they would reach a mile high! The earth is very old.

Fossils are old too, but some are older than others. Many Paleozoic fossils we find in Indiana are of animals that are 300-500 million years old. Five hundred jars of seeds would need to be lined up to represent the oldest of these Paleozoic animals. If we lined 500 jars up side by side they would span the length of a football field!

The first dinosaurs appeared approximately 248 million years ago. They ruled the earth for over 180 million years before they became extinct 65 million years ago. Ask the students to imagine that each seed represents one year that dinosaurs lived on the earth. If you took all of those seeds and weighed them they would weigh as much as a car!

Ice age animals like mammoths, mastodons, sabertooths, and giant beavers lived during the Pleistocene period (2 mya - 8,000 ya). Pick up two handfuls of seeds. This long ago, mastodonts roamed Indiana.

Remove one handful of seeds. This represents approximately 6000 years. Six thousand years ago towns were only beginning to emerge. Most people lived in bands or tribes. The wheel had not yet been invented. There was no written history. There was no alphabet. Pottery was just starting to become widespread in the Old World, and was not yet present in the New World. Stone was still the most common material used to make tools.

Activity 3

Objectives

- ❑ Students will learn how to use a scale; and
- ❑ Students will learn how to comprehend and calculate word problems.

Indiana's Academic Standards

Science: 4.2.1, 4.2.4, 5.1.1, 6.2.2, 6.5.2

Mathematics: 4.2.2, 4.7.3, 5.2.1

Supplies:

Balance scale

Metric conversion table (if necessary)

Instructions:

In the above activity, 12 pounds of birdseed is used to represent one million years. How is it known that this is one million? In order to figure out how much one million of something would weigh, one can simply weigh the item then multiply that times one million. However, what if the item is too small to be weighed? Pose this problem to the class using beads, birdseed, rice, pennies, raisins, marbles, or some other item which is very small. How would you figure out how to weigh one million? Count 100 beads (or a substitute item). Weigh these beads using a balance scale. If 100 beads weighs x amount, how much would one million weigh? Have the students write this as an equation. If a 4 oz bag of beads cost \$3.00, how much would it cost to buy one million beads? Ask volunteers to weigh items from their desks. How much would one million pencils weigh? How much would one million notebooks weigh? How much would one million paper clips weigh?

Activity 4

Objectives

- ❑ Students will understand a timeline; and
- ❑ Students will understand the importance of major events on a timeline.

Indiana's Academic Standards

Science: 5.5.1, 5.6.2, 6.7.2

Supplies:

Paper and pencil

Instructions:

Create a time line of your life. Just as the earth's history is marked by special events such as ice ages or mass extinctions, your life is marked by significant events as well. These events might include the birth of a new brother or sister, moving to a new house, starting at a new school, getting a pet, or breaking an arm or leg. Create the time line from when you were born to the present time, and include at least 8 significant events.

Activity 5**Objectives**

- ☐ Students will learn what a fossil is.

Indiana's Academic Standards

Science: 4.1.1

Supplies:

Various items which represent fossils and non-fossils such as a chicken bone, a rock, a bit of fossilized bone (easily purchased from a museum gift shop or a rock shop)

An old penny

A crinoid stem or other Paleozoic fossil (plentiful in southern Indiana creeks and stream beds)

Instructions:

What is a fossil? This is a game that can be played with the entire class using several items that are fossils and several that are not. Discuss the definition of a fossil with the class. After displaying each item, ask the class to vote on whether or not this item is a fossil. Discuss the reasoning behind their answers.

Activity 6**Objectives**

- ☐ Students will learn that the earth is layered; and
- ☐ Students will learn how this affects fossils.

Indiana's Academic Standards

Science: 4.6.3

Supplies:

Small glass jar (one per student)

Colored sand (3 or more colors)

Instructions:

Simulate the deposition of layers of earth by using colored sand. Have the students each bring from home a small glass jar such as a baby food jar, mayonnaise jar, etc. With different colors of sand, each student will fill his/her jar. Discuss layers and how these relate to the age of various fossils. Which layers were laid down first? If there were fossils in these layers, where would the oldest be? Sometimes layers are thicker in some areas and thinner in some areas. Have the students try this with the colored sand. How does the deposition of layers affect how frequently a paleontologist will find fossils of a particular age in a particular location?

Activity 7**Objectives**

- ❑ Students will learn what materials become a fossil; and
- ❑ Students will learn how to use the scientific method.

Indiana's Academic Standards

Science: 5.2.4, 6.2.5, 6.7.2

Supplies:

Five or six plant or animal remains

Labeled markers

Shovel or trowel

Handout "To be or not to be (a fossil)"

Instructions:

To be or not to be (a fossil). Did all hard parts of ancient animals and plants become fossils? No! The conditions had to be just right. Try this experiment to see what can happen on the way to becoming (or not becoming) a fossil. Take five or six plant and animal remains. These might include: a steak bone with meat on it, a clean chicken bone, a shell, an apple, a piece of cotton fabric, or a stick. Dig a hole about six inches deep for each item in an area of the school grounds which can be sectioned off. Place the item in the hole and cover it with dirt, then dampen it with water. Remember to mark the holes so that you can find them again. Return after one month and dig up the remains. What did you find? How many of these have the potential to become fossils?

Using the handout, "To be or not to be (a fossil)," create a chart based on the outcome of this class activity. List the items buried on the first column of the chart. Next, create a column of predictions. In this space, write a sentence describing what you think will happen to each item. The third column will be saved for the actual results. In the fourth column, write your conclusions as to whether each item has a chance of becoming a fossil. Given another 10,000 years, which of the items do you think could become fossils? Did these conclusions match your predictions?

Activity 8**Objectives**

- ❑ Students will be able to recognize a fossil mold and a fossil cast, and will be able to distinguish them from each other.

Indiana's Academic Standards

Science: 5.2.7, 6.7.2

Supplies:

Paper cups (one per student)
Mixing container
Stirring sticks
Plaster of Paris
Sea shells
Non-hardening clay

Instructions:

Making clay molds and plaster casts. As the students complete each step, discuss how the same steps occurred in nature.

1. Hand out small lumps of clay, a paper cup, and one shell to each student. Have the students press the lump of clay into the bottom of their cup. Next, press the shell into the clay. Have the students remove the shells. This is the mold. A fossil mold forms in a similar manner.
2. To create the cast, mix the plaster with water in the mixing container according to the instructions on the box.
3. Pour the plaster into each student's mold. The plaster should just cover the clay in the bottom of the cup.
4. Allow the casts three hours to dry before peeling away the paper cup and clay. Each student will now have a clay mold and a plaster cast.

Activity 9**Objectives**

- ☐ Students will learn how to excavate a fossil; and
- ☐ Students will enhance note taking skills to record scientific data.

Indiana's Academic Standards

Science: 5.2.4

Supplies:

Plaster of Paris
Small paper cups (one per student)
Chicken bones or shells (one per student)
Paper towels
Sawdust or dirt
Spoon for mixing
Wooden stirring rods
Stiff glue brushes
Plastic pitcher

Instructions:

Simulated fossil excavation! Some types of fossils, such as dinosaur bones, are embedded in rock and must be excavated using very careful techniques. In this activity, students will be able to carefully search for fossils in matrix (Plaster of Paris mixed with dirt or sawdust) using renditions of paleontologist tools, and record what they find. To prepare, mix the Plaster of Paris and the dirt (or sawdust) until the consistency is almost as thick as mashed potatoes. Pour this into the paper cups until it just fills the bottom. Drop in the chicken bone (or shell) and cover with the remaining plaster mixture. One cup should be prepared per student. This will take one or two days to set, so it should be done in advance. Remove the hardened plaster from the paper cup. Each student will have one plaster lump in front of him/her. Using the wooden stirring rod as a pick, each student can pick away at the matrix to reveal the embedded fossil. Remind the students to take care so as not to damage the Afossil.® The students can use the glue brushes to remove the smaller particles from the Afossil.® The students will then measure their Afossil® and record a description of it as well as its dimensions in their notebooks. They may also draw a picture of the fossil.

Activity 10**Objectives**

- ❑ Students will learn about Indiana bedrock; and
- ❑ Students will learn the different materials that make up the bedrock.

Indiana's Academic Standards

Social Studies: 4.3.6

Science: 6.5.4, 6.7.2

Supplies:

Handout "Generalized Bedrock Map of Indiana"

Different colored markers or pencils

Instructions:

Indiana bedrock. Bedrock is the solid rock found beneath the ground. Bedrock can be exposed at the surface or buried beneath hundreds of yards of sand, soil, and gravel (the glacial till). The ages of Indiana bedrock are shown on the attached map. Glacial boundaries are indicated by the dotted line. In the glaciated regions of Indiana, bedrock is rarely exposed due to the abundance of glacial sediments in the area. Have the class color code the geologic time periods on the map. Point out the various features of the map, including the glacial boundaries. Have them answer the following questions about the map. (Students should consult the geologic time scale to answer some of the questions.)

1. Which of these bedrock layers is the oldest? (Ordovician)
2. How old is it? (505-440 million years old)
3. What city would you travel to in order to find exposed bedrock from the Mississippian? (Martinsville, Bloomington, or New Albany)
4. What city would you travel to in order to find exposed bedrock from the Pennsylvanian? (Evansville)
5. Suppose a rock was found on the surface of the ground in South Bend, Indiana that was dated to be more than 600 million years old! How would you explain this? (The bedrock in the South Bend area that would contain fossils is buried under glacial sediment. Even if this bedrock were exposed, the top layer of bedrock is Mississippian in age (360-325 million years old). A rock more than 600 million years old would have had to have been brought down by the glaciers and deposited in the area.

Activity 11

Objectives

- ❑ Students will be able to identify limestone; and
- ❑ Students will be able how to identify calcium carbonate in other rocks.

Indiana's Academic Standards

Science: 5.2.4, 6.5.4

Supplies:

Limestone
Sandstone
Siltstone
Shale
Muriatic acid
Eyedropper
Goggles

Instructions:

Identifying limestone experiment. One way to identify limestone is to place a drop of muriatic acid on the stone in question. (Muriatic acid is diluted hydrochloric acid which can easily be purchased at a hardware store.) The limestone will effervesce (bubble up) due to a reaction between the acid and the calcium carbonate in the limestone. The bubbles which appear are carbon dioxide. With an eye dropper, place a drop of acid on each of the sedimentary rocks. (Rocks other than the sedimentary rocks listed, shale, siltstone and sandstone, may be used as well.) Have the students set up a chart that illustrates their predictions for each of the rocks, as well as the results of the experiment.

Activity 12

Objectives

- ❑ Students will learn the daily tasks of a paleontologist; and
- ❑ Students will learn to form a report based on interview questions.

Indiana's Academic Standards

Science: 4.2.5, 6.1.4, 6.1.5

Supplies:

Paper and pencil

Instructions:

Research the daily tasks of a paleontologist. Call your local museum or university to get in touch with a paleontologist. Conduct a phone interview, or visit the paleontologist at his/her place of work after school or over the weekend. Ask him/her about what type of tasks he/she does, then write a report that illustrates a day in the life of a paleontologist. Questions to ask may include:

What kind of things did you study in school?

What type of fossils do you work with most?

Where did those fossils come from?

Have you ever been on a paleontological dig? What was it like? What did you discover?

How do you care for the fossils after they are found?

What is the most exciting part of being a paleontologist?

What type of tools do you use?

Activity 13

Objectives

- ❑ Students will learn to classify animals based on traits and characteristics; and
- ❑ Students will be able to organize scientific data.

Indiana's Academic Standards

Science: 4.6.4, 5.1.1,

Supplies:

Paper and pencils

Instructions:

Choose 20 animals. It does not matter which animals you choose, as long as they are all different. Now sort these animals into groups based on their characteristics. Label each group with the characteristic or characteristics they share in common, such as Aanimals that fly,@ Aanimals that are found on a farm@ or Aanimals with fur.@ Try sorting your list in different ways that make sense to you. On a different sheet of paper sort the animals again, but this time try to do it by relatedness. Group those animals you think are most closely related based on traits or characteristics that these animals have in common. Compare your system of classifying animals with the classification system used by scientists.

Activity 14

Objectives

- ❑ Students will learn to identify an object and record data pertaining to it; and
- ❑ Students will be able to make a display label explaining the object.

Indiana's Academic Standards

Science: 5.2.4, 5.5.1

Supplies:

Pencil and paper

Instructions:

Paleontologists record as much information about a fossil as they possibly can, including where it is found, when it was found, it=s size, weight, color and overall appearance. In a city park, field, forest, creek bed, or other natural area, search for a natural object that is special to you. It may be a bone, shell, rock, fossil, nut, feather, etc. Record the location where you found the object and describe its appearance. Measure the object with a ruler. With this information, create a label for the object.

Activity 15

Objectives

- ❑ Students will learn to identify fossils by sight and name.

Indiana's Academic Standards

Science: 4.1.1

Supplies:

Fossil picture cards
Fossil facts sheet
Scissors
Glue
Construction paper

Instructions:

With the same materials, two games can be played, fossil bingo and fossil memory game.

1. To play fossil bingo, copy the fossil bingo pictures and distribute one to each student along with scissors, glue, and construction paper. Each student will cut out nine fossil pictures and will arrange these in random fashion on the construction paper, securing each with glue. This will become the student's fossil bingo card. To play, read the descriptions on Indiana's Paleozoic fossils to the class. The students will place a marker (bits of construction paper will serve well as markers) on the appropriate square. The first students with a "bingo" should raise their hands. The game can continue until all students have gotten a bingo.

2. The fossil memory game is played just like the game "Memory." Cut out the attached picture cards and the corresponding fossil name cards. Shuffle the cards and place them all face down on the table or floor, with the picture cards on one side and the corresponding names on the other. The student will turn over one card from each pile. The students must make a match-picture and name. If a match is made, both cards are removed. If not, the cards are both turned back over, and another student takes a turn. You may have the students draw and design their own fossil cards and make their own game to play!

Evaluation

A point scale can evaluate student's work during lessons. Teacher can also custom-design an evaluation that could include observation, a numeric rating scale and/or class discussion.

Student Evaluation

Tell the students the word *evaluate* means to weigh, to judge, or to determine the value of something. The most important evaluator is the student himself or herself. Give each student a copy of the "I LEARNED..." questions with each activity. Instruct them to turn their answers to the questions in with the assignment. Together as a class go over their questions and answers, discussing how the answers to these questions could help the students to judge the quality of their own work, and improve it.

Geologic Time

Name _____ Date _____

Fill in the blank.

Words used: geologist, paleontologist, Paleozoic, Mesozoic, Cenozoic, Pleistocene, epoch

Millions of years ago, before the time of the dinosaurs, Indiana was covered by a warm shallow sea.

_____s who study fossils from this era, which is known as the

_____, believe that the climate at this time was warm and tropical.

During the _____ era, dinosaurs roamed the earth. However, any remains of dinosaurs in Indiana have since eroded away.

The Ice Age occurred during the _____ epoch of the Cenozoic era. An _____ is a further subdivision of a period. The _____ is the most recent geologic era.

Guess what? Any rock you pick up in Indiana is likely to have been formed millions of years ago! Scientists who study rocks are called _____s.

Complete the geologic time line by entering missing eras and dates.

Place a star next to the name of each era from which we can find fossils in Indiana.

	Mesozoic	
544 mya - 248 mya		65 mya - present

Fossil Formation

Name _____

Date _____

Which of the following are considered fossils?

- _____ A chicken bone which has been buried in your yard for 10 years
- _____ The footprints of a dinosaur which have been preserved in stone
- _____ Eggs from a turtle that lived 70 million years ago
- _____ A sedimentary rock that is 400 million years old
- _____ An insect preserved in amber 40 million years ago
- _____ A piece of wood from a house built 200 years ago
- _____ Petrified wood
- _____ The skeleton of the world's last passenger pigeon which died in 1914

True or False:

- _____ In order for something to become fossilized, it must be buried quickly.
- _____ All sedimentary rocks contain fossils.
- _____ A fossil is the remains of a plant or animal that lived long ago.
- _____ Minerals in the area surrounding a fossil are likely to determine its color.
- _____ Every dinosaur that ever roamed the earth is now a fossil. We just haven't found them all yet.
- _____ The imprint of a shell in limestone is not a fossil. Only the shell itself can become a fossil.
- _____ A natural cast is a type of fossil because it is evidence of an ancient life form.
- _____ The fossilization process only takes a few days, especially if it is hot out.
- _____ Fossils are found in sedimentary rocks.
- _____ Only dinosaur bones are fossils. Other animal bones from millions of years ago are not.

Discovering Fossils

Name _____ Date _____

Which of the following would be used by a paleontologist?

- _____ A pair of binoculars to see far away fossils
- _____ A chisel to help get fossils out of sedimentary rock
- _____ A blowtorch to heat the rock surrounding the fossil
- _____ A dental pick to scrape rock from a fossil bone
- _____ Aluminum foil and plaster to help protect a fossil mammoth bone while it is being moved from place to place
- _____ A brush to clear dust from a fossil
- _____ A bucket of acid to dissolve the rock away from a Paleozoic fossil

Which of the following are sedimentary rocks? (Remember, fossils can only be found in sedimentary rocks, never in igneous or metamorphic rocks.)

- _____ limestone
- _____ granite
- _____ quartz
- _____ sandstone
- _____ shale
- _____ marble
- _____ lava

In order to reconstruct ancient Paleozoic environments, which of the following would a paleontologist want to know?

- _____ The layer of rock in which a fossil was found
- _____ The distance between the location of the fossil and present-day sea level
- _____ The size and weight of the fossil
- _____ The other kinds of fossils found in the same area
- _____ The genus and species name of the fossil
- _____ The types of animals living in that area today
- _____ The way that the fossil smells

Paleozoic Fossils

Name _____ Date _____

Which of the following things are living relatives of Indiana=s Paleozoic plants and animals? Put a T by the correct answer.

- | | |
|-------------------------|--------------------------|
| _____ goldfish | _____ dolphin |
| _____ nautilus | _____ jellyfish |
| _____ horseshoe crab | _____ starfish |
| _____ gastropod (snail) | _____ sea turtle |
| _____ oak tree | _____ sea lily (crinoid) |
| _____ fern | _____ Loch Ness monster |

Match each animal with the group (phylum) to which it belongs. Group names may be used more than once or not at all.

- | | |
|-------------------|------------------|
| _____ sand dollar | A. Mollusks |
| _____ jellyfish | B. Brachiopods |
| _____ blastoid | C. Echinoderms |
| _____ clam | D. Bryozoans |
| _____ coral | E. Arthropods |
| _____ crinoid | F. Coelenterates |
| _____ nautiloid | |
| _____ trilobite | |
| _____ lobster | |
| _____ snail | |
| _____ spider | |

Paleozoic Animals

Name _____ Date _____

Draw a line from each Paleozoic animal name to its matching picture.

Brachiopod



Trilobite



Crinoid



Coral



Bryozoan



Cephalopod



Clam

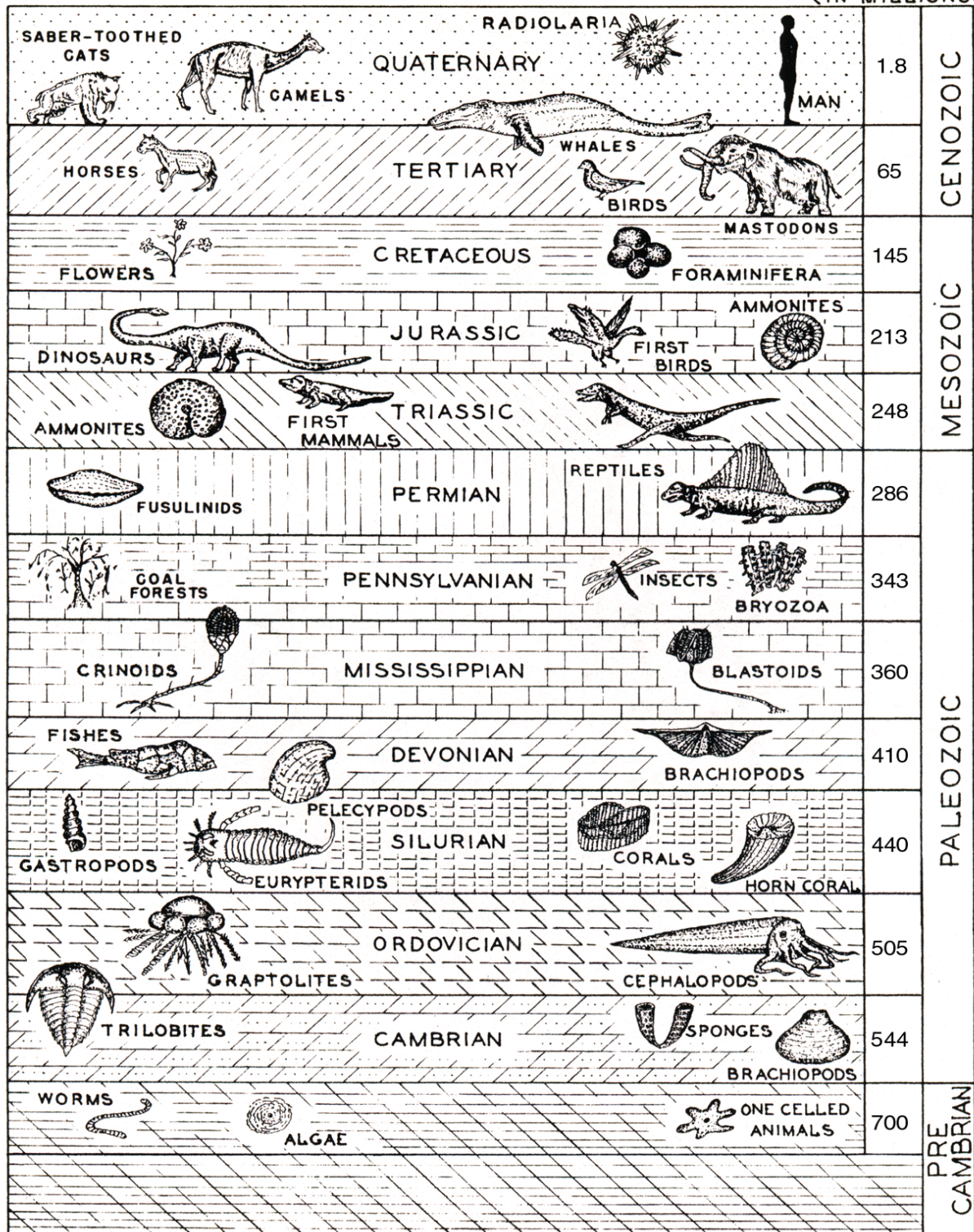


Snail



GEOLOGIC TIME CHART

(YEARS AGO
(IN MILLIONS))



EARTH' S TIME LINE			
Period	Millions of Years Ago	Examples of Life Forms	Length of Section
Quaternary	1.8	Modern humans begin to develop into what they are today. Ice Age animals abound.	2 cm
Tertiary	65	Age of mammals begins. Flowering plants are common. Birds take modern forms.	63 cm
Mass Extinction -- many marine species are killed and the dinosaur era ends			
Cretaceous	145	Dinosaurs are well-advanced. Flowering plants appear. Small mammals present.	80 cm
Jurassic	213	Reptiles dominate on land, air, and sea.	68 cm
Triassic	248	First dinosaurs. Mammalian ancestors appear.	35 cm
Great Mass Extinction -- many species die			
Permian	286	Reptiles begin to dominate. Dinosaur ancestors appear. Pine trees first appear.	38 cm
Carboniferous	360	Reptiles, dragonflies, cockroaches and snails appear. Amphibians and ferns flourish.	74 cm
Devonian	410	First land vertebrates and insects appear. Fish dominate seas.	50 cm
Silurian	440	Jawed fish appear. The first land plants and animals appear	30 cm
Ordovician	505	Still only ocean life. Armored jawless fish appear.	65 cm
Cambrian	544	Trilobites, coral reefs, starfish, and brachiopods appear.	39 cm
Precambrian	700	Worms and jellyfish appear.	1.56 m
	3800	Life first appears in ocean - single celled algae and bacteria.	31 m
	4000	Primordial sea forms, no life.	2 m
	4600	Earth forms.	6 m

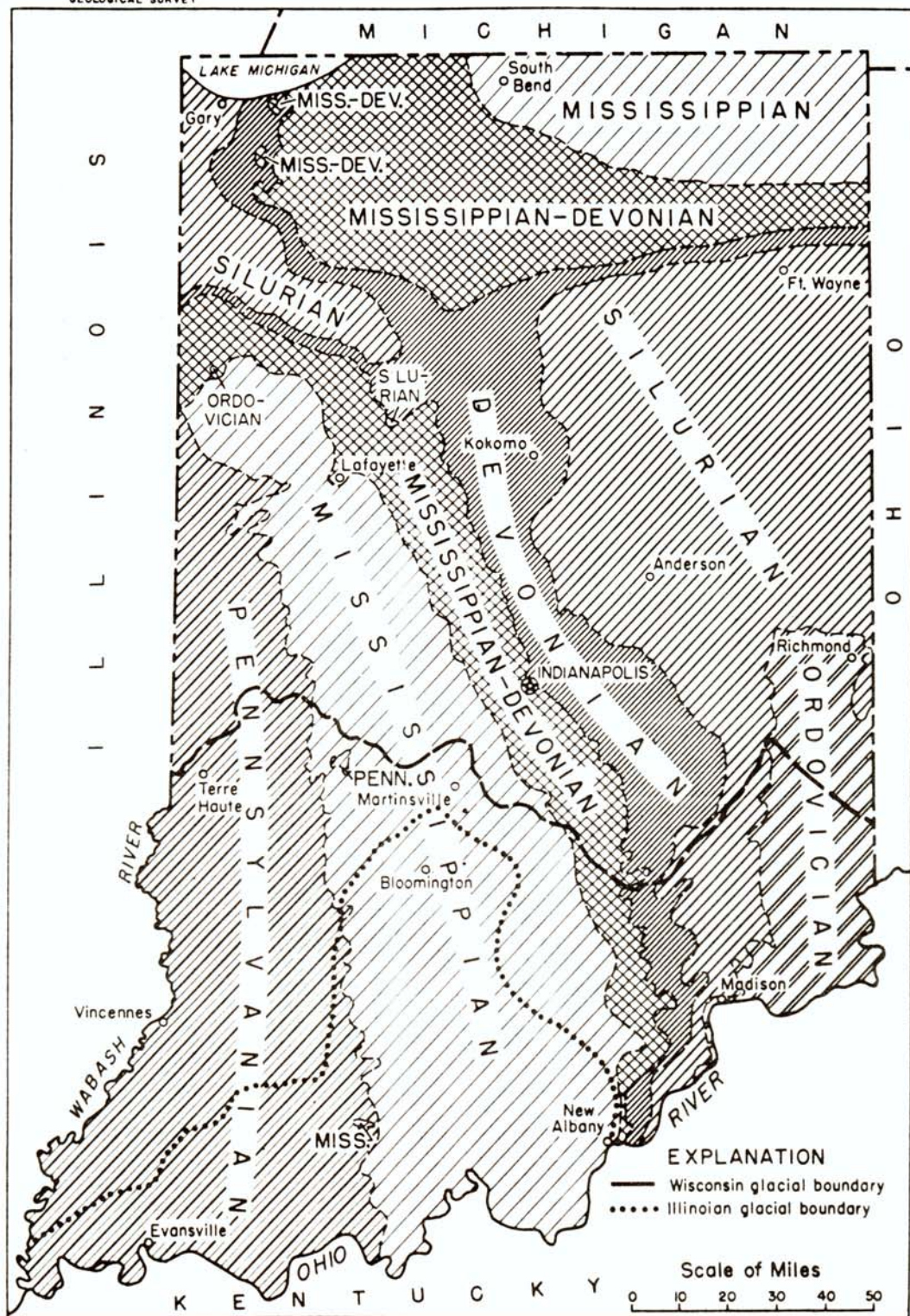
Scale: 1 meter = 100 million years, 1 centimeter = 1 million years

To be or not to be (a fossil)

Item	Prediction	Results	Conclusion
apple	<i>The apple will rot. It will not become a fossil.</i>	<i>The apple was rotten and mushy.</i>	<i>This will not become a fossil because it rotted. This agrees with my prediction.</i>
steak bone (with meat)	<i>The meat will rot, but the bone will stay and could become a fossil.</i>	<i>The steak bone was missing because an animal dug it up and took it away.</i>	<i>This will not become a fossil because it was eaten. This does not agree with my prediction.</i>
clean chicken bone	<i>The chicken bone will remain unchanged. It could become a fossil.</i>	<i>The chicken bone was unchanged.</i>	<i>This could become a fossil. This agrees with my prediction.</i>
shell	<i>The shell will remain unchanged. It could become a fossil.</i>	<i>The shell was unchanged.</i>	<i>This could become a fossil. This agrees with my prediction.</i>
stick	<i>The stick will remain unchanged because it is hard wood. It could become a fossil.</i>	<i>The stick was still there, but it was very soft and crumbling apart.</i>	<i>This will not become a fossil because it will eventually rot away. This does not agree with my prediction.</i>

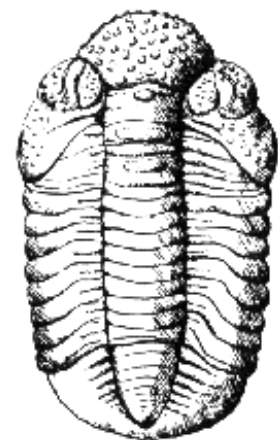
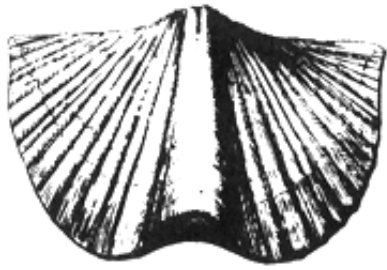
To be or not to be (a fossil)

Item	Prediction	Results	Conclusion



GENERALIZED BEDROCK MAP OF INDIANA

Compiled by J.B. Patton
January 1, 1952



BRACHIOPOD	BRYOZOAN	CEPHALOPOD
PELECYPOD (CLAM)	CRINOID	FERN
HORN CORAL	GASTROPOD (SNAIL)	TRILOBITE

FOSSIL FACT SHEET

Cephalopods include nautiloids and ammonites. Nautiloids are the ancestors of the modern nautilus, octopus, and squid. The shell could be cone-shaped or coiled, and was chambered. At the large end was an open chamber where the animal lived. Some nautiloids of geologic past were about 15 feet long. If it resembled its descendants, it had tentacles, eyes, and a mouth with hard teeth.

Trilobites had segmented bodies, a hard jointed shell like a beetle=s that was shed several times during its life, and compound eyes like a fly. It is thought to have eaten the nutrients in mud, just as earthworms do today. When trilobites felt threatened or scared they curled up like a pill bug. The closest living relative of the trilobite is the horseshoe crab. More distant relatives of the trilobite include other arthropods such as insects, spiders, centipedes, crabs, pill bugs, lobsters, and crayfish. Trilobites ranged from an inch or two long to nearly two feet! They were very successful during the Paleozoic, existing for nearly 300 million years. Trilobites were extinct by the end of the Paleozoic.

Crinoids are relatives of other echinoderms such as star fish, sea urchins, and sand dollars, and are still living in the seas today. Crinoid fossils are very plentiful in Indiana. Crinoid stems, sometimes called **Indian beads** are the parts of crinoids most commonly found. The crinoid as a whole, however, looked a lot like a flower, and in fact the name crinoid means **lily-like**. Crinoids were not plants, but stationary animals that were often rooted. The petal-like tentacles of the crinoid collected nutrients from the surrounding ocean water and directed them toward the animal=s mouth.

Gastropods, more commonly known as snails, were present in the Paleozoic seas. There were freshwater, saltwater, and land-dwelling varieties. Snails of the Paleozoic are very similar to those living today. Snails are characterized by having a single shell which is almost always coiled.

Prehistoric **bryozoans** built colonies which either were attached to the sea floor branching out like antlers, or were growing over the shells of other ocean animals. Their lifestyle was very similar to that of corals in that they produced a protective limey layer around themselves. Their feeding style, however, was more similar to the brachiopods. Although bryozoans are not as well recognized as corals, hundreds of types of bryozoans live in today=s oceans.

Brachiopods are the most plentiful marine fossils from the Paleozoic. Unlike clams, which have two identical shells, brachiopods have two unlike shells. The shells usually have ridges and sometimes have short knobs, suggesting spines in life. Brachiopods are still living in oceans today, but there are much fewer species now than during the Paleozoic.

Horn coral is an example of a solitary coral. The space that this single animal would have occupied becomes filled with sediment, and is not an open cavity in fossil form. Many people mistake horn coral for a horn, a claw or a tooth.

The youngest Paleozoic fossils found in Indiana are **fern fossils**. They come from trees with fern-like leaves. Fossilized portions of tree bark, stems, and roots have also been found, revealing what the plant looked like. Fern fossils are often found in mold and cast form. Since these plant parts are soft and decompose rapidly, fern fossils will only form when buried quickly by sediment. When the sediment hardens and the fern rots away, a mold is left. Other sediment falling on top of this fern mold will create a cast. Sedimentary nodules can be broken open to reveal both the mold and the cast.

Pelecypods, or clams, have two identical shells which appear to be mirror images of each other. Clams are still living today, and can be found in both fresh and salt water environments.

Common Paleozoic Fossils of Undersea Indiana

(Phyla and Classes)

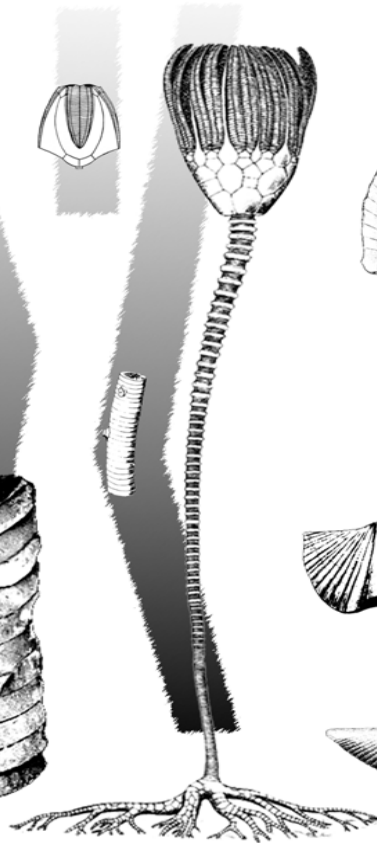
Mollusks

Gastropods Pelecypods Cephalopods



Echinoderms

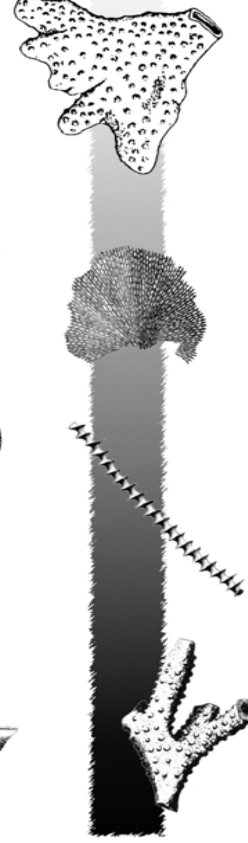
Blastoids Crinoids



Brachiopods

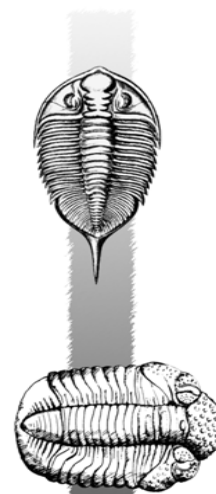


Bryozoans



Arthropods

Trilobites



Coelenterates

Corals



Worksheet Answers

1. Geologic Time

Test Your Knowledge

Paleontologist, Paleozoic
Mesozoic
Pleistocene, epoch, Cenozoic
geologist

<i>Paleozoic</i> ¹	Mesozoic	<i>Cenozoic</i> ¹
544 mya - 248 mya	<i>248 mya - 65 mya</i>	65 mya - present

2. Fossil Formation

Test Your Knowledge

- The footprints of a dinosaur which have been preserved in stone
- Eggs from a turtle that lived 70 million years ago
- An insect preserved in amber that is 40 million years old
- Petrified wood

T, F, T, T, F, F, T, F, T, F

3. Discovering Fossils

Which of the following would be used by a paleontologist?

- T A chisel to help get fossils out of sedimentary rock
- T A dental pick to scrape rock from a fossil
- T Aluminum foil and plaster to help protect the fossil while it is being moved from place to place
- T A brush to clear dust from the fossil

Which of the following are sedimentary rocks?

- T limestone
- T sandstone
- T shale

In order to reconstruct ancient environments, which of the following would a paleontologist want to know?

- T The layer of rock in which a fossil was found
- T The size and weight of the fossil
- T The other kinds of fossils found in the same area
- T The genus and species name of the fossil

4. Paleozoic Fossils

Which of the following things are living relatives of Indiana=s Paleozoic plants and animals?

T nautilus

T jellyfish

T horseshoe crab

T starfish

T gastropod (snail)

T sea lily (crinoid)

T fern

Match each animal with the group (phylum) to which it belongs.

C sand dollar

A nautiloid

F jellyfish

E trilobite

C blastoid

E lobster

A clam

A snail

F coral

E spider

C crinoid

“I LEARNED...” QUESTIONS

Name _____ Date _____

- 1. What were you expected to do for this assignment?**
- 2. In this assignment, what did you do well?**
- 3. If you had to do this assignment over, what would you do differently?**
- 4. What help do you need from me?**

LESSON PLAN EVALUATION

Your feedback is important to us. We welcome your comments to help us plan lessons in the future. Please check your responses and return to the Indiana State Museum. You may return the evaluation by mail, fax, or e-mail to:

Attention: Teacher and Student Program Coordinator, ssteinem@dnr.state.in.us

Fax 317.233.8268

1. Please indicate the lesson plan you received:

- ☐ James Whitcomb Riley
- ☐ Madam C. J. Walker
- ☐ Young Abraham Lincoln
- ☐ The Anti-Slavery Movement
- ☐ Modes of Transportation
- ☐ Quilts
- ☐ Civil War Booklet
- ☐ Amish of Indiana
- ☐ Oliver P. Morton
- ☐ Ice Age Animals
- ☐ Fossils

1. Did you find the lesson plan easy to understand and use?

Yes ____ No ____ Not sure ____

If "no," what was the problem? _____

2. Were the connections to the state standards appropriate?

Yes ____ No ____ Not sure ____

Comments: _____

3. Was the length of this lesson plan

too short? ____ too long? ____ just right? ____

Comments: _____

4. Was the lesson plan appropriate for the grade/ability level of your students?

Yes ____ No ____ Not sure ____

Comments: _____

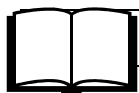
5. What activity did your students like the best? _____

6. What activity did your student like the least? _____

Why? _____

How could we improve it? _____

Additional comments: _____



RESOURCES

Books

Casanova, Richard, *Fossil Collecting*.

Kirkaldy, J.F., *Fossils in Color*.

Kirkaldy, J.F., *The Study of Fossils*.

Mathews, William H. III, *Fossils-An Introduction to Prehistoric Life*.

Palmer, Lawrence E., *Fossils*.

Wicander, Reed and Monroe, James S., *Historical Geology*.

WEBSITES

www.rom.on.ca/quiz/fossil/

<http://web.ukonline.co.uk/conker/fossils/>

<http://pubs.usgs.gov/gip/fossils/contents.html>

www.ucmp.berkeley.edu/

www.geobob.com

<http://drydredgers.org/>

<http://adamite.igs.indiana.edu/>